Name: Date:

Worksheet: City Climate

Pick a city/location

1. Go to this website: https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/city/mapping
2. Notice we see many locations around the US. By default, you can see last month's average temperature.
3. You can change the year, month, and time scale to think about some places you might want to visit. Choose a location that you want to analyze for this worksheet. Do not pick the same city as anyone sitting near you.
4. Click on that dot to go to "**City Time Series**". **What city/location did you pick?**

Get 5 years of monthly temperature averages

5. Set `Time Scale` to `1-Month`.
6. Set `Month` to `All Months`.
7. Set `Start Year` to `2020`.
8. Set `End Year` to `2024`.
9. Click `Plot`. Check the graph to make sure no data are missing. If there are gaps, choose a difference city.

Data wrangling (always the hardest part of data analysis)

Our goal is to get those 5 years of data into Desmos. I'm going to guess the best way is to download the csv file, but we might need to pivot.

10. Click to Download the `CSV` file.
11. In a new google sheet, Import the csv file.
12. Fix column A so under Date is numbers 1 through 60 instead of 202001, 202002, etc...
13. Copy the two columns into a new expression in Desmos. They should automatically fill a table.

Add Regression

14. Near the top-left of the Desmos table is an icon that looks like a bunch of dots with a line through them. When you hover over it, it should say `Add Regression`. Click this icon.
15. The default regression is a linear regression. Notice you'll see a linear equation with two parameters, the slope and a y-intercept: ($y = mx + b$, with parameters m and b). **What could those parameters represent in this scenario?**

16. Change the regression to `Sinusoidal Regression`. You'll now see an equation with four parameters: $y = A \cdot \sin(Bx - C) + D$.
17. We called parameter A the amplitude. **What is your value for parameter A? And what does it represent in this scenario?**

18. We called parameter D the vertical shift (and the midline is at $y = D$. **What is your value for parameter D? And what does it represent in this scenario?**

19. **What is your value for parameter B?**

20. Parameter B is called the angular frequency. To find the period (P), use this formula: $P = \frac{2\pi}{B}$. **What is your value for P and what does it represent in this scenario?**

21. Parameter C changes the initial phase. Because your data starts in winter, and you are using a sine function, the wave is probably shifted about a quarter of a period, so about $\pi/2 \approx 1.5707963$ radians. Since the coldest months are probably labeled 1 or 2 (and 13 or 14 and... NOT 0, 12, 24...) your C is probably a bit more than $\pi/2$. What is your value for C?

22. **Using the best-fit curve, predict the average temperature at your location for April 2025.**

MORE DATA!

23. Go back to your City Time Series (at the NCEI/NOAA website). Keep the same settings as before, except this time set `Start Year` to as early as possible, and set `End Year` to 2025. Click Plot.
24. If you see any gaps in the curve, set the `Start Year` to after the gap. We do not have the time for dealing with those gaps. Download the CSV, fix the Date column, and copy/paste into Desmos.
25. Add Regression. Look at the linear regression. **Do you think the slope is meaningful?**

26. Switch to a sinusoidal regression. Desmos probably fails to identify the period. Let's set the period to exactly 12 months to help Desmos fit the data better. Click the 3-dot icon to the right of the drop-down menu, and click `Export as custom regression`.
27. Replace b with $\frac{2\pi}{12}$, since we know the period should be 12 months. That should help a lot.
28. Let's add another term to the custom regression. Add mx_1, so the custom regression now looks like:

$$y_1 \sim a \cdot \sin\left(\frac{2\pi}{12}x_1 + c\right) + d + mx_1$$

What effect does this additional term have on the curve?

Why might it be important for a climate model to include this mx_1 term?